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Aeropalynological Study of Yangmingshan National Park, Taiwan

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ABSTRACT: An aeropalynological study was conducted within Yangmingshan National Park, Taiwan. At the study site (Hsiao-Kuan-Yin), a Burkard seven-day volumetric pollen trap was used to collect samples from April 1997 to March 1998. Over this period, a total of 64 taxa belonging to 46 families and 54 genera were identified in the pollen assemblage. The decreasing abundance of pollen and spores was in the following sequence: Gramineae (23.1%), Urticaceae (17.2%), *Trema* (15.3%), *Ardisia* (7.0%), *Broussonetia* (5.6%), *Cyathea* (4.5%), *Piper* (3.4%), *Mallotus* (2.9%), other Euphorbiaceae (2.5%), *Humulus* (1.4%) and *Pinus* (1.2%). Two major pollen seasons, from March to May and in October, were dominated by arboreal pollen and Gramineae pollen, respectively, while only a small amount of pollen and fern spores were collected from November to February. The major species of pollen also varied by season: *Trema* dominated in April and May, *Ardisia* in June, *Cyathea* in July and August, *Mallotus paniculatus* in September, Gramineae in October, and Urticaceae and *Broussonetia* in March. A pollen calendar was constructed to illustrate this seasonal variation in the quantitative and qualitative characteristics of airborne pollen and spores.

KEY WORDS: Aeropalynology, Pollen calendar, Pollen dispersal, Yangmingshan National Park.

INTRODUCTION

Aeropalynological studies have become increasingly common in the last few decades. Studies have considered pollen dispersal in the air (Alcazar *et al.*, 1999; Bicakci *et al.*, 1999; Latorre and Bianchi, 1998), the relationship between vegetation composition and pollen types (Cour *et al.*, 1999; Woo *et al.*, 1998), and the relationship between airborne pollen and climate change (Cour *et al.*, 1999; Frei, 1998). A number of studies have been done to correlate airborne pollen with symptoms of hay fever and asthma suffered by human populations in various regions of the world (Spieksma and Nikkels, 1999; Chakraborty *et al.*, 1998; Chowdhury *et al.*, 1998; Gonzalez *et al.*, 1998; Bass and Morgan, 1997; Ekebom *et al.*, 1997; Yli, 1997).

In Taiwan, studies of aeropalylogy have been done in the Taipei Basin (Chao *et al.*, 1962; Chen *et al.*, 1972; Wang, 1973; Han *et al.*, 1976; Chen and Huang, 1980; Tsou and Huang, 1982; Chen, 1984; Chen and Chien, 1986; Peng and Chen, 1996, 1997; Yang and Chen, 1998), and the middle (Huang and Chung, 1973), western (Tsou *et al.*, 1997), southwestern (Kuoh *et al.*, 1999) and southern parts (Huang, 1998) of the island. However, a study of the mountainous urban regions has never been attempted.

Yangmingshan National Park is located to the north of Taipei City (Fig. 1), covering an area of ca. 11,456 ha, including the Tatun volcanic mountains, which range from 500 to 1,120 m a.s.l. Basic information about the vegetation of the park has been provided by Shibahara

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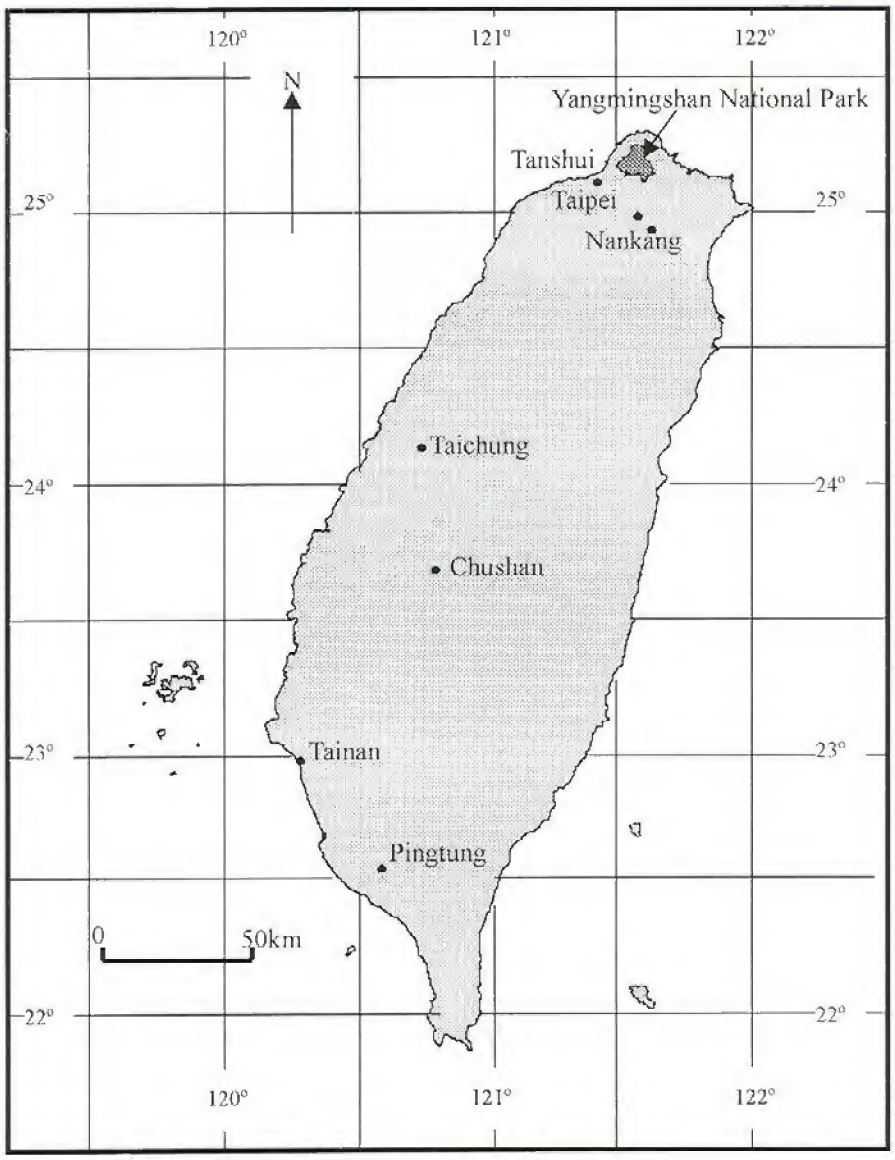

Fig. 1. Geographical location of Yangmingshan National Park in Taiwan.

(1939), Huang *et al.* (1983), Hsu and Lin (1986), and Chou and Lee (1991). Three main plant communities occur in the park: swamp, grassland, and evergreen forest. The majority of the park area is occupied by evergreen forest, which occurs between 400 and 900 m a.s.l. Lauraceae, especially *Persea thunbergii* and *P. japonica*, are the most dominant plants in the forest. *Ardisia sieboldii*, *Itea parvifolia*, *Prunus phaeosticta*, *Liquidambar formosana*, *Diospyros morrisiana*, and *Cleyera japonica* are the subdominant species (Huang *et al.*, 1983). Swamps occupy only a small area, while grasslands account for 8.7% of the park. In the grasslands, *Miscanthus sinensis* var. *glaber* and dwarf bamboo (*Arundinaria usawai*) cover an area of 432 and 574 ha, respectively (Hsu and Lin, 1986).

Although the park's vegetation has been well studied, the relationship between vegetation and airborne pollen and fern spores has not been considered. Because information regarding airborne pollen and spores from this area is important to the Taipei metropolitan area, a study of aeropalynology was undertaken.

MATERIALS AND METHODS

Sampling site

The sampling site (Hsiao-Kuan-Yin, N25°10'56", E121°32'17") was located near the middle of Yangmingshan National Park at an altitude of ca. 800 m (Fig. 2). In the vicinity of this site there is grassland mainly composed of *Miscanthus sinensis* var. *glober* and dwarf bamboo. Only 15 other species of plants, belonging to 12 families, are found in this area. Most are perennials, including *Farfugium japonicum* var. *formosanum*, *Dianella ensifolia*, *Histiopteris incisa*, *Dicranopteris linearis*, and *Melastoma candidium*, which occurred in small numbers (Shibahara, 1939).

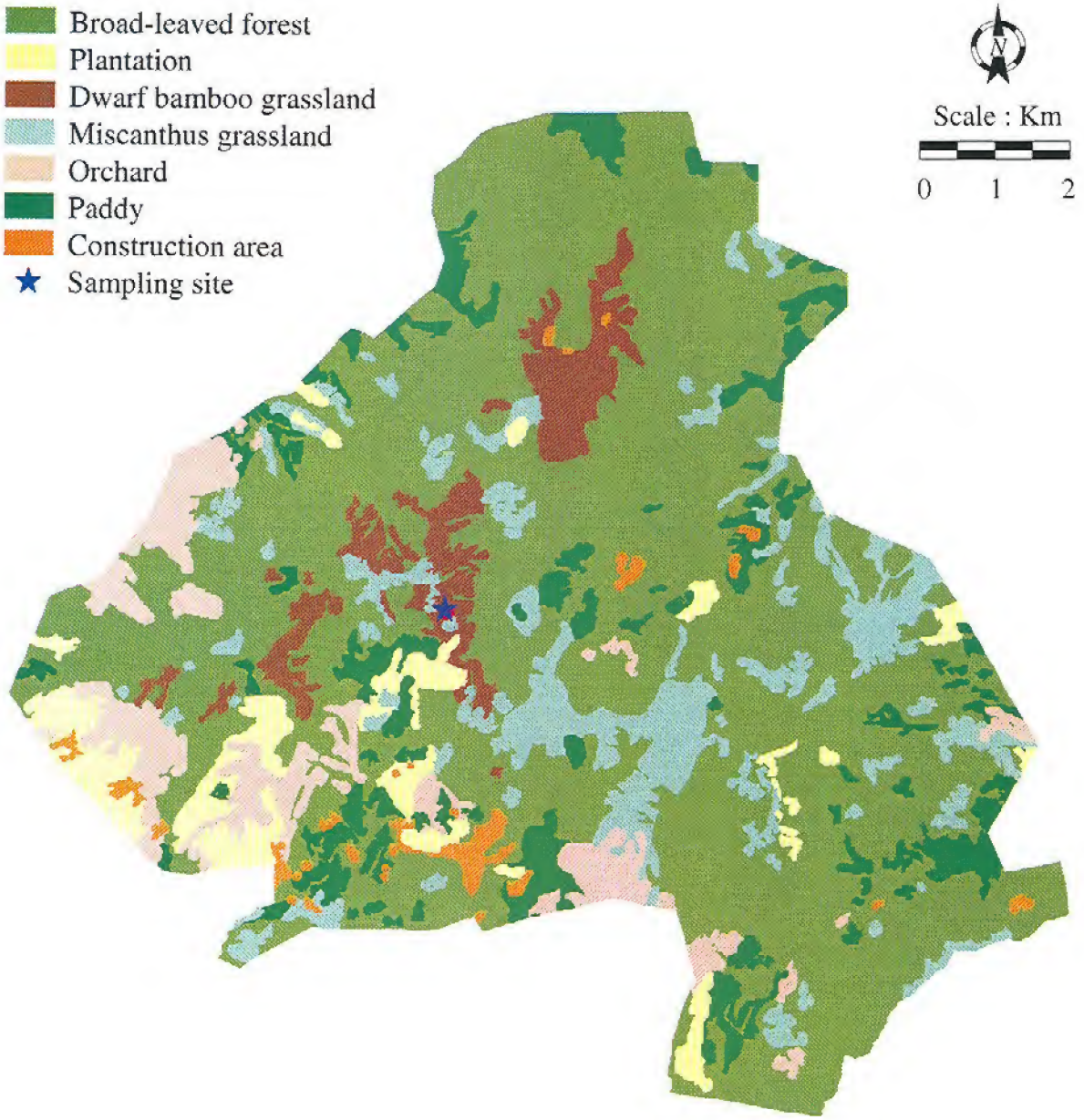

Fig. 2. The vegetation composition around the sampling site at Hsiao-Kuan-Yin in Yangmingshan National Park (Modified from Huang *et al.* (1983) by Prof. Pei-Fen Lee).

Weather conditions at the sampling site

During the study, the highest (22.6 °C) and lowest (9.6 °C) air temperatures were recorded in August and January, respectively (Fig. 3). The average yearly temperature was 16.8 °C. Precipitation was 3,800 mm per year. A rainy season, between September and December, was related to the monsoon. During the time of this study, the rainy season occurred between June and August. Winds were west-southwardly during the monsoon, and toward various directions in other seasons. The rainy season was characterized by foggy weather, up to 15 days per month. In the dry season, mainly in the spring, precipitation was as low as 130 mm per month.

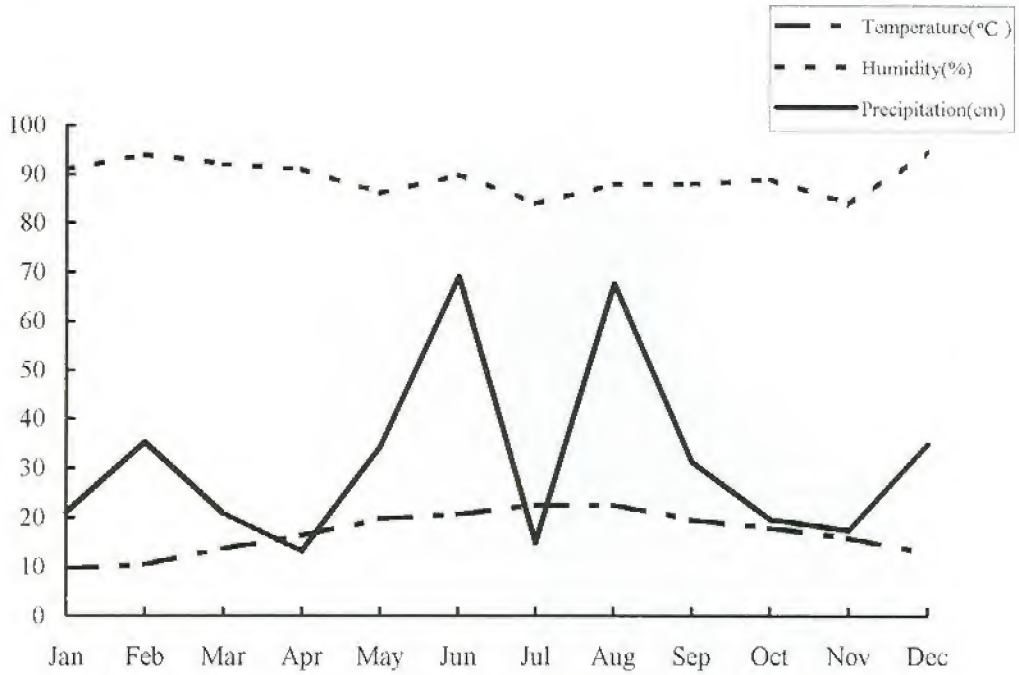

Fig. 3. Meteorological data from the An-Pu Station in Yangmingshan National Park during 1997. (The data used are from the Central Weather Bureau, Taiwan)

Sampling and preparation of pollen samples

A Burkard seven-day volumetric pollen trap was installed for sampling from April 1997 to March 1998. The methods of Peng and Chen (1996) were used to collect airborne pollen and spores on a Melinex tape coated with Gelvotal solution. Using an inflow rate of 10 L min^{-1}, the tape was exposed to air samples through a 2 mm x 14 mm orifice, with the tape secured to a drum that rotated at 48 mm d^{-1}. After 7 days exposure the tape was collected and cut into 7 sections, providing samples for each day. The samples were embedded in Entellan (Merck, Germany) for light microscopic observations.

The pollen grains and fern spores were identified under a Leitz Diaplan microscope. A minimum sampling of one transverse traverse per 2 mm from the trapping tape was performed. The counts were corrected by a factor to obtain an estimate of pollen deposition per hour or day. Monthly abundances of pollen grains were calculated from pollen counts performed every two days. References for taxonomic identification were Huang (1972, 1981) and Chen (1988) for pollen and fern spores. All botanical names used in this are according to the Flora of Taiwan (Li *et al.*, 1979).

RESULTS

Pollen taxa

A total of 64 taxa, belonging to 46 families and 54 genera were identified in the samples of airborne pollen and spores from Yangmingshan National Park (Table 1). Of the taxa identified, 33 families and 40 genera were angiosperms, 3 families and 3 genera were gymnosperms, and 10 families and 11 genera were ferns. Of the angiospermous pollen, Euphorbiaceae (5 taxa), Moraceae (4 taxa), and Ulmaceae (3 taxa) contributed the largest numbers of species.

Table 1. List of pollen and fern spore taxa caught in Yangmingshan National Park from April 1997 to March 1998.

Angiospermous plants			
Amaranthaceae	*Amaranthus*	Moraceae	*Broussonetia*
Aquifoliaceae	*Ilex*		*Ficus*
Betulaceae	*Alnus*		*Humulus*
Caprifoliaceae	*Viburnum*		*Morus*
Casuarinaceae	*Casuarina*	Myricaceae	*Myrica*
Chenopodiaceae	*Chenopodium*	Myrsinaceae	*Ardisia*
Compositae	*Artemisia*	Myrtaceae	
Cyperaceae		Oleaceae	*Fraxinus*
Elaeocarpaceae	*Elaeocarpus*		*Ligustrum*
Euphorbiaceae	*Bischofia*	Piperaceae	*Piper*
	Glochidion	Plantaginaceae	*Plantago*
	Macaranga	Porteaceae	*Helicia*
	Mallotus	Rosaceae	*Prunus*
	Ricinus	Saxifragaceae	*Itea*
Fagaceae	*Castanopsis*	Scrophulariaceae	*Mazus*
	Cyclobalanopsis	Theaceae	*Adinandra*
Gramineae			*Eurya*
Hamamelidaceae	*Liquidambar*	Trochodendraceae	*Trochodendra*
Juglandaceae	*Engelhardtia*	Ulmaceae	*Celtis*
	Juglans		*Trema*
Lauraceae			*Ulmus*
Leguminosae	*Acacia*	Umbelliferae	
Lythraceae	*Lagerstroemia*	Urticaceae	
Gymnospermous plants			
Cupressaceae	*Juniperus*	Taxodiaceae	*Cryptomeria*
Pinaceae	*Pinus*		
Ferns			
Aspleniaceae	*Asplenium*	Gleicheniaceae	*Dicranopteris*
Athyriaceae	*Diplazium*	Lycopodiaceae	*Lycopodium cernuum*
Cyatheaceae	*Cyathea*	Oleandraceae	*Nephrolepis*
Davalliaceae	*Davallia*	Pteridaceae	*Pteris*
Dennstaedtiaceae	*Dennstaedtia*	Selaginellaceae	*Selaginella*
	Microlepia		

Gramineae accounted for up to 23.1% of the total pollen in terms of quantity, and was therefore the most abundant type in the study area. Subdominant pollen was from Urticaceae (17.2%) and *Trema* (15.3%). Pollen of *Ardisia* (7.0%), *Broussonetia* (5.6%), *Cyathea* (4.5%), *Piper* (3.4%), *Mallotus* (2.9%), other Euphorbiaceae (2.5%), *Humulus* (1.4%) and *Pinus* (1.2%) played a less important role in the study area (Fig. 4). Other pollen taxa with frequency less than 1% are listed in Table 2.

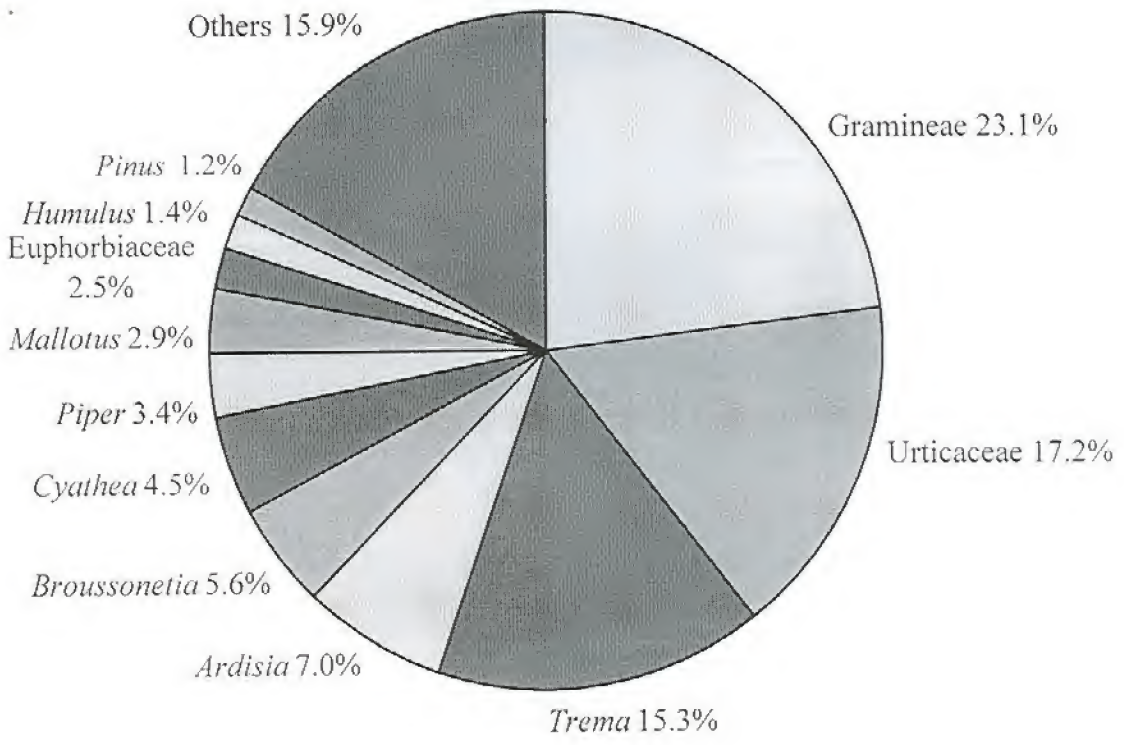

Fig. 4. Composition of pollen and spore species in Yangmingshan National Park from April 1997 to March 1998.

Table 2. Taxa of source plants with airborne pollen and spore frequency (F) more than 0.06%.

F>1%		1%>F>0.5%		0.5%>F>0.1%				0.1%>F>0.06%	
Gramineae	23.13%	*Morus*	0.89%	*Artemisia*	0.48%	*Myrica*	0.18%	Lauraceae	0.08%
Urticaceae	17.18%	*Castanopsis*	0.77%	trilete spore	0.40%	*Alnus*	0.16%	*Davallia*	0.08%
Trema	15.33%	monolete spore	0.75%	Myrtaceae	0.38%	*Trochodendron*	0.12%	*Ricinus*	0.07%
Ardisia	6.98%	*Dicranopteris*	0.72%	*Nephrolepis*	0.34%	*Chenopodium*	0.15%	*Prunus*	0.06%
unknown	5.66%	*Macaranga*	0.71%	*Juniperus*	0.34%	*Plantago*	0.14%	*Juglans*	0.06%
Broussonetia	5.62%	Cyperaceae	0.58%	*Casuarina*	0.30%	*Viburnum*	0.13%	*Fraxinus*	0.06%
Cyathea	4.46%			Compositae	0.26%	*Liquidambar*	0.12%	*Asplenium*	0.06%
Piper	3.37%			*Diplazium*	0.23%	*Microlepia*	0.11%		
Mallotus	2.91%			*Elaeocarpus*	0.22%	*Celtis*	0.11%		
Euphorbiacea	2.47%			*Acacia*	0.22%	*Ulmus*	0.10%		
Humulus	1.44%					*Lagerstroemia*	0.10%		
Pinus	1.17%								

Seasonal fluctuation in pollen and spore density

The density of airborne pollen fluctuated seasonally. Distinct pollen peaks occurred in spring, from March to May, and in autumn, during October (Fig. 5). The amount of pollen encountered in these peaks was 53.2% and 20.0%, respectively, of the yearly total (Fig. 6). The highest daily pollen density, as high as 145 pollen grains m^{-3} day^{-1}, was recorded on October 14 (Fig. 5). The lowest one was observed between November and December, contributing just 0.4 and 0.5%, respectively, of the yearly total. Less than 200 pollen grains per month were trapped during this time (Fig. 6).

Seasonal succession in pollen and spore species

Over the study period, the highest diversity of pollen taxa was observed in spring, in April and May, with as many as 35 and 37 taxa, respectively (Fig. 7). The lowest diversity of airborne pollen was observed in November and December, with as few as 6 taxa in either month. From January to June, arboreal pollen (AP) consistently was more abundant than non-arboreal pollen (NAP) and fern spores (Fig. 8). During this period, pollen of Urticaceae, *Broussonetia*, *Trema* and *Ardisia* was the most important contributor. In July and August, fern spores,

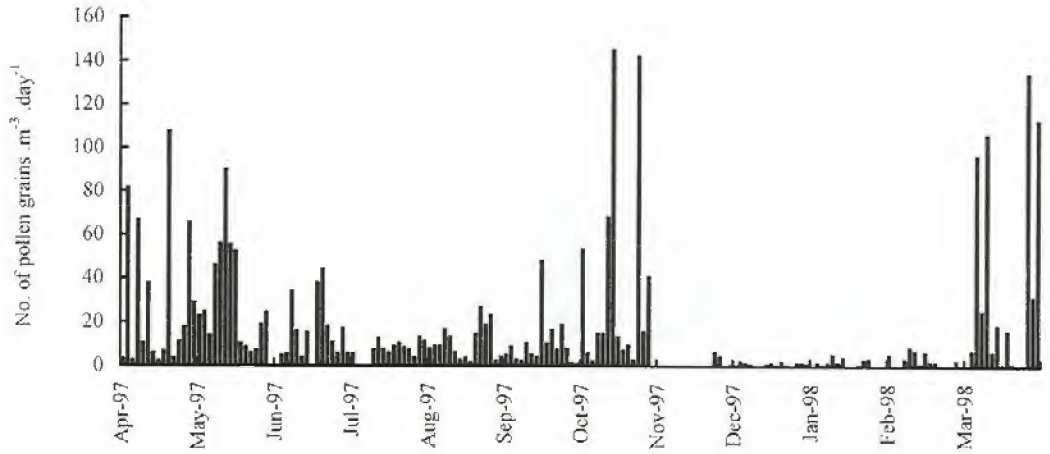

Fig. 5. Variation in daily pollen and spore density in Yangmingshan National Park from April 1997 to March 1998.

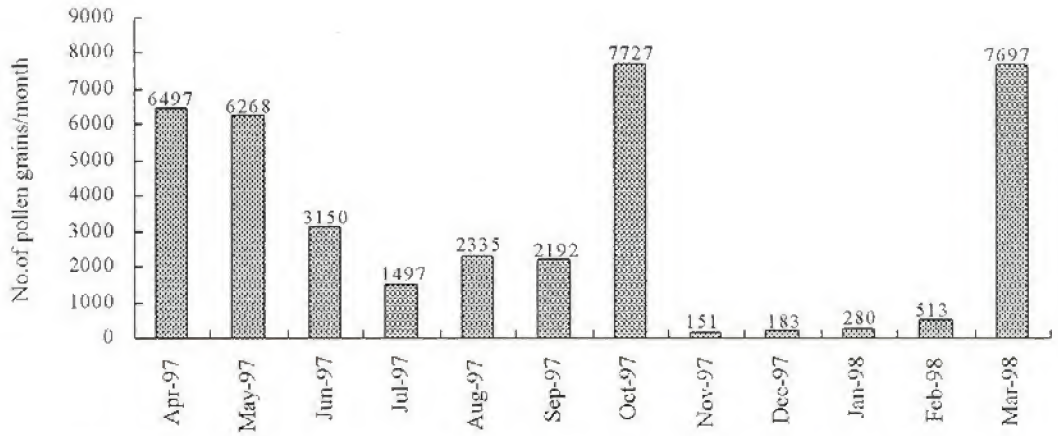

Fig. 6. Variation in total pollen and spore counts per month in Yangmingshan National Park from April 1997 to March 1998.

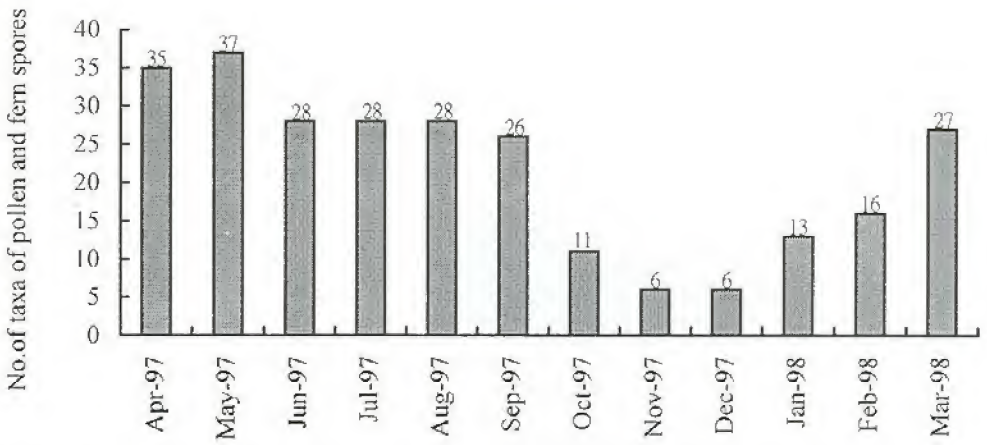

Fig. 7. Variation in total pollen and spore taxa per month in Yangmingshan National Park from April 1997 to March 1998.

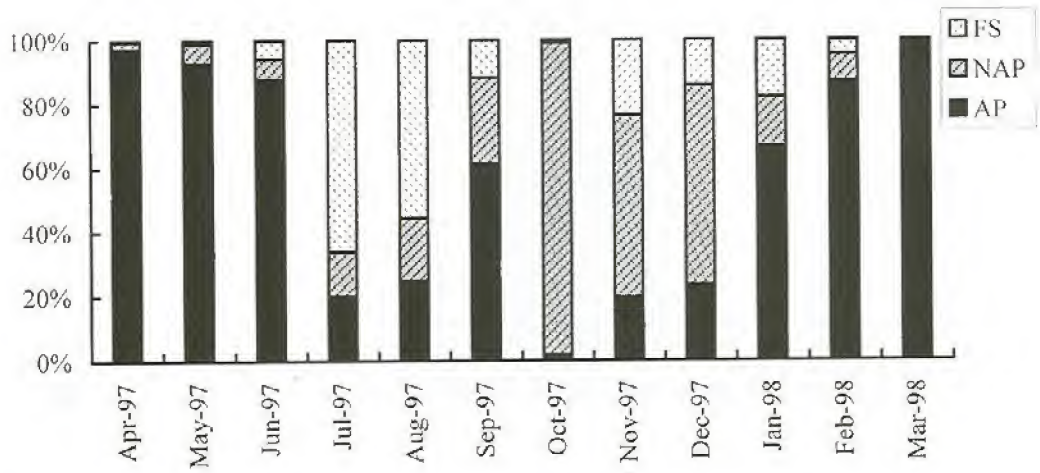

Fig. 8. Ratio of arboreal pollen (AP), non-arboreal pollen (NAP) and fern spores (FS) in Yangmingshan National Park from April 1997 to March 1998.

especially spores from *Cyathea*, replaced dominance of AP. In September, flowering of *Mallotus paniculatus* coincided with a prominent increase in the density of AP, giving rise to the dominance of AP over NAP. After September, an increase in the density of *Miscanthus* pollen resulted in the dominance of NAP over AP. This situation persisted until the end of December.

In January and February, the density of airborne pollen and spores was low, and the main airborne pollen taxa, in small amounts, were *Broussonetia*, Urticaceae, *Pinus*, and *Trema* (Table 3). In March, a dramatic increase in pollen density was observed, and was mainly due to an increase in Urticaceae and *Broussonetia* pollen, along with a small amount of pollen of *Morus*, *Pinus* and *Trema* (Fig. 9). Pollen of Urticaceae and *Broussonetia* reached their maxima in this month, with a total of 5,106 and 1,376 grains, respectively, collected (Table 3). Pollen density decreased in April, and the dominant taxon was replaced by *Trema* (2,438 grains), which dominated into May (3,190 grains). Samples contained pollen of this genus from April until the end of August, reflecting the long period of flowering of the plant. Pollen

Table 3. List of total pollen and fern spore counts per month in Yangmingshan National Park from April 1997 to March 1998.

	1997-Apr	1997-May	1997-Jun	1997-Jul	1997-Aug	1997-Sep	1997-Oct	1997-Nov	1997-Dec	1998-Jan	1998-Feb	1998-Mar	Subtotal
Acacia	10	47	23	0	5	0	0	0	0	0	0	0	85
Adinandra	0	0	0	0	0	0	0	0	5	0	0	0	5
Alnus	0	0	0	0	5		47	0	10	0	0	0	62
Amaranthus	0	0	0	5	5	0	0	0	0	5	0	0	15
Ardisia	103	350	2145	20	0	0	0	0	19	10	10	28	2685
Artemisia	0	0	0	5	39	126	14	0	0	0	0	0	184
Bischofia	5	0	0	0	0	0	0	0	0	0	0	0	5
Broussonetia	422	5	10	5	33	61	0	0	0	51	201	1376	2164
Casuarina	14	84	5	0	0	0	0	0	0	0	0	14	117
Castanopsis	103	5	56	42	5	0	0	5	0	0	0	80	296
Celtis	19	0	0	0	0	5	0	0	0	0	0	19	43
Chenopodium	5	15	0	0	0	24	5	0	5	0	5	0	59
Compositae	0	19	10	5	10	33	0	0	0	5	5	14	101
Cryptomeria	5	5	0	0	5	0	0	5	0	0	0	0	20
Cyclobalanopsis	0	10	0	0	0	5	0	0	0	0	0	0	15
Cyperaceae	30	24	0	29	52	79	10	0	0	0	0	0	224
Elaeocarpus	19	5	61	0	0	0	0	0	0	0	0	0	85
Engelhardtia	5	0	9	0	0	0	0	0	0	0	0	5	19
Euphorbiaceae	834	117	0	0	0	0	0	0	0	0	0	0	951
Eurya	0	0	5	0	0	0	0	0	0	0	0	0	5
Ficus	0	0	0	0	0	0	0	0	0	0	0	14	14
Fraxinus	10	0	0	5	0	0	0	0	0	0	0	10	25
Glochidion	0	5	0	0	0	0	0	0	0	0	0	5	10
Gramineae	76	274	178	131	321	270	7426	70	100	20	28	10	8904
Helicia	0	0	0	9	0	0	0	0	0	0	0	0	9
Humulus	48	61	37	5	10	382	0	5	5	0	0	0	553
Ilex	0	14	0	0	0	0	0	0	0	0	0	0	14
Itea	0	15	0	0	0	0	0	0	0	0	0	0	15
Juglans	20	5	0	0	0	0	0	0	0	0	0	0	25
Juniperus	0	0	0	0	0	0	0	0	0	0	10	122	132
Lagerstroemia	5	0	10	10	9	0	0	0	0	0	5	0	39
Lauraceae	15	10	0	0	0	0	0	0	0	5	0	0	30
Ligustrum	5	5	5	0	5	0	0	0	0	0	0	0	20
Liquidambar	0	19	9	5	0	0	0	0	0	0	0	14	47
Macaranga	229	24	5	0	0	14	0	0	0	0	0	0	272
Mallotus	28	183	5	5	274	573	48	0	0	0	0	5	1121
Mazus	0	0	0	0	0	0	0	0	0	0	0	5	5
Morus	37	34	24	14	14	5	0	0	0	0	24	190	342
Myrica	5	5	0	0	0	0	0	0	0	0	0	58	68
Myrtaceae	14	102	0	14	0	0	0	0	0	0	10	5	145
Pinus	113	118	19	0	0	0	5	0	0	20	39	136	450
Piper	387	708	71	23	25	24	0	0	0	5	5	51	1299
Plantago	19	24	0	0	0	0	0	0	0	0	0	9	52
Prunus	0	0	0	0	0	0	0	0	0	0	5	19	24
Ricinus	0	0	0	0	0	0	0	0	0	0	0	28	28
Saxifragaceae	5	5	0	0	0	5	0	0	0	0	0	0	15
Taxodiaceae	0	9	0	0	5	0	0	0	0	0	0	0	14
Trema	2438	3190	25	47	90	5	0	0	0	10	10	85	5900
Trochodendron	0	57	0	0	0	0	0	0	0	0	0	0	57
Ulmus	0	19	0	0	0	10	0	0	0	0	0	10	39
Umbelliferae	10	0	0	5	0	5	0	0	0	0	0	0	20
Urticaceae	940	177	57	56	10	127	42	9	0	28	62	5106	6614
Viburnum	0	9	0	0	42	0	0	0	0	0	0	0	51
Cyathea	5	29	62	611	782	141	72	0	0	10	0	5	1717
Asplenium	5	0	5	0	9	5	0	0	0	0	0	0	24
Davallia	0	0	0	5	5	19	0	0	0	0	0	0	29
Dennstaedtia	0	0	5	15	0	0	0	0	0	0	0	0	20
Dicranopteris	10	0	15	66	159	19	5	0	0	0	0	5	279
Diplazium	0	0	10	14	33	5	0	0	5	0	5	15	87
Lycopodium cernuun	0	0	0	5	5	0	0	0	0	0	0	0	10
Microlepia	0	0	0	10	29	0	0	0	0	5	0	0	44
Nephrolepis	0	5	29	33	38	10	9	5	0	0	0	0	129
Pteris	0	0	0	5	0	5	0	0	0	0	0	0	10
Selaginella	0	0	5	0	0	0	0	0	0	0	5	0	10
monolete spore	0	19	10	66	94	23	0	19	19	15	10	15	290
trilete spore	5	14	30	27	58	10	0	5	0	5	0	0	154
unknown	494	443	210	200	159	187	44	28	15	86	74	239	2179
Subtotal	6497	6268	3150	1497	2335	2177	7727	151	183	280	513	7697	Σ=38490

of Euphorbiaceae, especially *Macaranga* was also prevalent in April, exhibiting its maximum occurrence at this time. In addition, pollen of *Piper*, *Pinus*, *Ardisia*, and *Castanopsis* was present, but at a low density. In May, *Trema* and *Piper* dominated the airborne pollen, along with lesser amounts of *Mallotus japonicus*, *Pinus* and Myrtaceae.

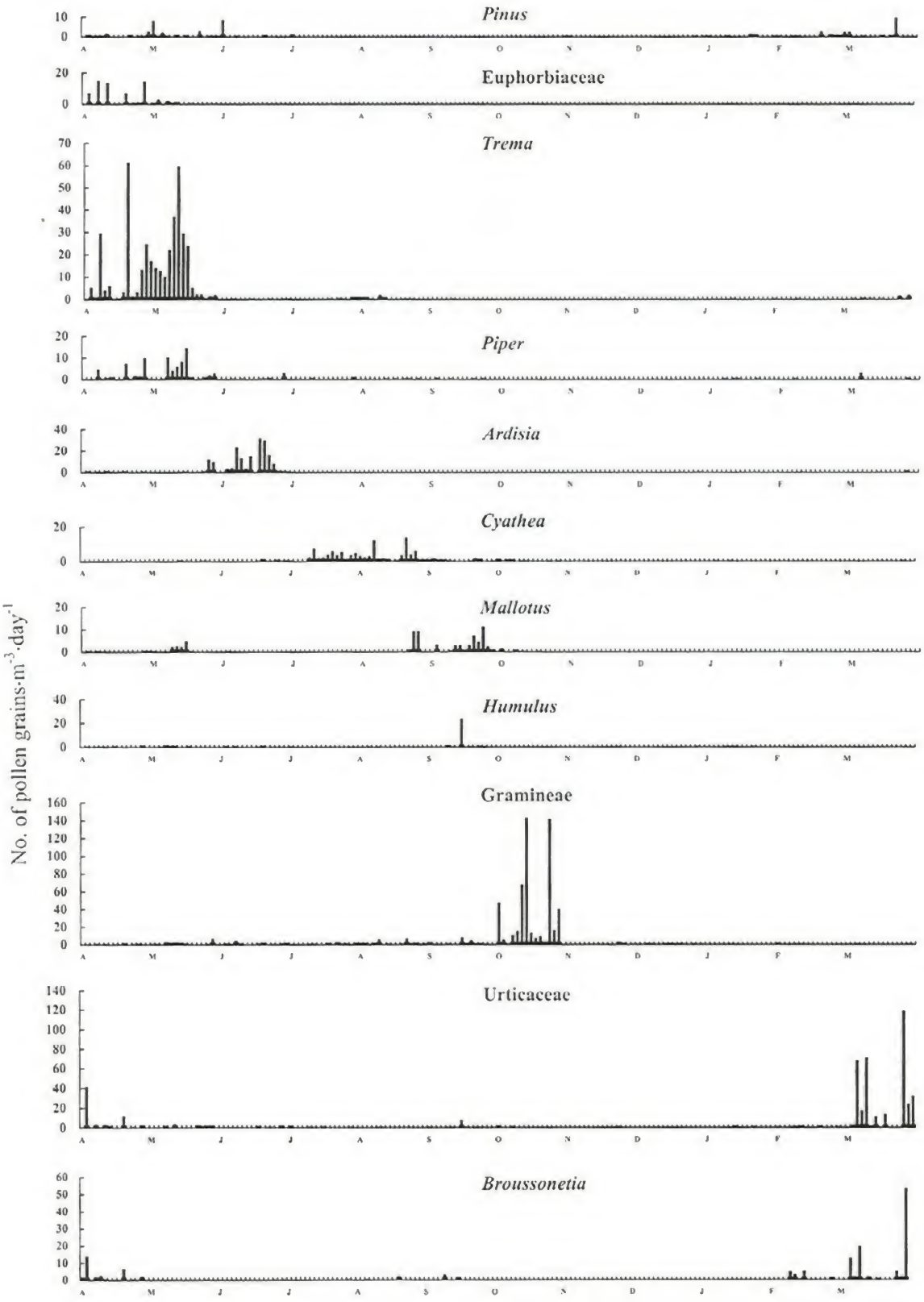

Fig. 9. Pollen calendar of Yangmingshan National Park from April 1997 to March 1998.

Pollen from *Ardisia* reached its maximum (2,145 grains) in June. This was associated with a gradual increase in the amounts of fern spores such as *Cyathea*, *Nephrolepis* and *Dicranopteris*. In July and August, *Cyathea* was the most important contributor to the airborne fern spores, while other fern taxa such as *Davallia*, *Dennstaedtia*, *Dicranopteris*, *Diplazium*, *Lycopodium*, *Microlepia*, *Nephrolepis* and *Pteris* were present at lower densities. In the vegetation, there were two species of *Cyathea*, namely *C. leptifera* and *C. spinulosa.* Because these species are similar in pollen morphology, they are cited only as *Cyathea.* Pollen from *Mallotus paniculatus* first appeared in late August. It became the most dominant species in September. The subdominant pollen at that time was from *Humulus* and *Artemisia.*

A second pollen peak was observed in October. During that time, Gramineae was most abundant (7,426 grains), with amounts of pollen as high as 83.4% of the yearly total. The dominance of Gramineae pollen occurred until the end of December, although pollen density was very low after November. In November and December, only a few pollen species, mainly of NAP were observed (Fig. 9). In the winter between January and February, AP from *Broussonetia*, Urticaceae, *Pinus* and *Trema* increased, indicating the beginning of the flowering season of these plants. A calendar (Fig. 9) summarizes the observed succession of 11 dominant airborne pollen and fern spores over the study period.

DISCUSSION

The finding of two distinct pollen seasons in Yangminshan National Park was consistent with results from other subtroptical and temperate zones in the northern hemisphere (Majas and Romero, 1992; Chakraborty *et al.*, 1998). The pattern also resembles that observed in other areas of northern (Peng and Chen, 1997; Yang and Chen, 1998) and southern Taiwan (Kuoh *et al.*, 1999; Huang, 1998), although there is a small variation in the timing of pollen peaks in the latter area.

The pollen calendar in Yangminshan National Park is somewhat different from that in Taipei City (Yang and Chen, 1998) and its urban areas Nankang (Chen, 1984; Chen and Chien, 1986) and Tanshui (Peng and Chen, 1997). In many areas of Taiwan, such as Tainan (Kuoh *et al.*, 1999) and Pintung (Huang, 1998), *Broussonetia* is the main contributor to the airborne pollen assemblage. In Yangminshan National Park, in contrast, the most dominant pollen was from Gramineae rather than *Broussonetia*. In nature, individuals of *Broussonetia* usually grow preferentially on lands with relatively more open space. Most of the land in Yangminshan National Park, however, is occupied by *Miscanthus sinensis* var. *glaber* or dwarf bamboo (*Arundinaria usawai*). This is possibly one of the reasons why there is less *Broussonetia* pollen in the area.

According to Hsu and Lin (1986) and Chou and Lee (1991), *Miscanthus sinensis* var. *glaber* and *Arundinaria usawai* generally cover 3.7% and 5.0%, respectively, of Yangminshan National Park. In the area surrounding our sampling site, however, these plants were more abundant (Fig. 2). In the airborne pollen samples, Gramineae pollen was as high as 23.1% of total pollen counts. Clearly, the composition of airborne pollen is strongly affected by the composition of the vegetation near the sampling site, as mentioned by many other authors (Alcazar *et al.*, 1999; Peng and Chen, 1997).

Miscanthus is represented by a single species, *M. sinensis* var. *glaber*, which is widely distributed in Yangmingshan National Park (Chou and Lee, 1991), and generally flowers from September to December, but flowering times may vary depending on elevation and other

factors. According to Chou and Lee (1991), *Miscanthus* populations near the sampling site usually flower from the beginning of October to the middle of November. In our study, the main peak of *Miscanthus* pollen was observed in October. This agrees with the results of the previous study.

Other than *Miscanthus*, rice (*Oryza sativa*) is one of the most important contributors to the airborne pollen in northern Taiwan (Chen, 1984; Chen and Chien, 1986; Peng and Chen, 1997; Yang and Chen, 1998). In the vicinity of the sampling site there are some rice fields, located in the village of Tsu-Tse-Hu, which is situated at a lower elevation (ca. 200 m a.s.l.). However, we did not collect any rice pollen in this study, suggesting that it was not transported across the elevation barrier.

Trema is the most abundant AP pollen in Yangmingshan National Park. It is contributed by various species of the genus in different seasons: in April and May by *T. orientalis* and in July and August by *T. cannabina*. The former species occurs on plains, riversides and hills, whereas the latter species occurs in open places and in secondary thickets at lower altitudes (Yang and Lu, 1996). Pollen of *Trema* was verified to be allergenic to adult respiratory allergic patients in India (Chakraborty *et al.*, 1998). In Taiwan, the allergenic effect of *Trema* pollen has not been investigated.

Plants of Lauraceae are one of dominant species in the vegetation of Yangmingshan National Park. However, their pollen occurred only sparsely in the pollen calendar, contributing ca. 0.08% of the yearly total (Table 2). Pollen of Lauraceae apparently represent a much lower percentage of the pollen total than the degree of their presence in the vegetation. The reason for such an underrepresentation is probably because plants of this family are entomophilous. Pollen of entomophilous species are usually trapped in small amounts during collection of airborne pollen.

Our study provides basic information about the pollen calendar and a comparison between the composition of vegetation and the pollen assemblage in Yangmingshan National Park. These data are useful for pollen analysis and pollen allergy studies in the Taipei area. The pollen calendar exhibits monthly variation in the abundance and time of appearance of each pollen species (Ong *et al.*, 1995). It is therefore desirable to have a long time series of data and, using statistical techniques, evaluate quantitatively the influence of parameters such as precipitation, humidity, and sunshine, which mostly influence flowering and pollen concentrations (Moreno *et al.*, 1998). Accordingly, further study is required to provide a more reliable and useful pollen calendar for the study area.

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陽明山國家公園空中孢粉學之研究

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摘　　要

本研究於陽明山國家公園小觀音置一空中孢粉收集器，收集空中花粉和蕨類孢子，以光學顯微鏡觀察並鑑定孢粉之種類及數量，完成 1997 年四月至 1998 年三月空中孢粉之鑑定。一年來出現的孢粉種類共 46 科 54 屬，其中禾本科的花粉佔全年總量的 23.1 %最為優勢，次為蕁麻科佔 17.2%，山黃麻屬佔 15.3 %，紫金牛屬佔 7.0 %，構樹屬佔 5.6 % ，杉欅屬佔 4.5%，胡椒屬佔 3.4%，野桐屬佔 2.9%，其餘的大戟科佔 2.5%，葎草屬佔 1.4%，松屬佔 1.2%。陽明山地區全年有二個明顯的主要花季：一為 3 月至 5 月，豐富的孢粉量由各樹種花粉構成；另一為 10 月，主要由禾本科花粉組成。1997 年四月和五月以山黃麻屬的花粉佔優勢，六月為紫金牛屬，七月和八月為杉欅屬，九月為白鮑子，十月為禾本科，十一月和十二月空中孢粉量非常少；1998 年一月和二月開始有新的樹種花粉出現，但量仍然很少，三月以蕁麻科和構樹屬的花粉佔優勢。本研究建立了陽明山國家公園的孢粉曆，提供了不同季節中空中孢粉種類和量的變化。

關鍵詞：空中孢粉學，孢粉曆，花粉散播，陽明山國家公園。

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